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THE MECHANISM OF PLUMAGE IN WATER BIRDS.

By Frederick J. Stubbs.

Most observers are familiar with the power of certain birds to alter the degree of their submergence in the water. It is many years since the question was first discussed—by Atkinson and Slaney in the second volume of 'The Zoologist,' and by Beverley Morris in the first volume of his 'Naturalist.' Since then other writers have published their views, without adding anything to our knowledge, and the mystery is as deep to-day as it was sixty years ago; so no apology seems necessary for this further attempt to solve the puzzle.

At times the Moorhen—as I have myself frequently observed—and almost certainly the Grebes, hold themselves beneath water by grasping the stems of aquatic plants. It has been denied that the Grebe has the power to so use its toes, but I have several times seen this bird disappear from sight, and remain hidden, under circumstances leaving no room for doubt that the bird was keeping itself beneath the surface by clinging to the vegetation, as a Moorhen will do. Before we state that a Grebe cannot use its toes for grasping, we must consider the structure of a bird's foot, and the way it is used in the case of the Moorhen and other birds. Owing to the form of the joint between the proximal phalanges and the tarso-metatarsus, the outer digits, when the foot is closed, press in laterally towards the

centre. The flexion of the toes is thus quite capable of providing sufficient lateral power to grasp small objects placed in the extreme angle. It is easily tested in a dead bird, and freely used by the Moorhen and its relatives when feeding on such substances as maize. Sometimes the hallux is used as a supplement, but generally the grain is held tight either between the second and third or the third and fourth digits. This is by the way; I mention it because the point has escaped notice, and the knowledge may be useful in a study of the Grebes beneath water.

Yet it often happens that a bird, from a position indicative of extreme buoyancy, will on alarm sink in the water until only the top of the back and the head and neck are visible, and this at times when the aid of such things as plants is out of the question. In fact, with the birds of the genus *Colymbus*, grasping is anatomically impossible, even did the foothold exist. The Red-throated Diver, on occasion, swims as high in the water as a Mallard; yet when alarmed it will sink until almost all the body is below the surface. This is true, to a certain extent, of all swimming birds. Even the surface-feeding Ducks (as Slaney noticed) are able to submerge their bodies to an extraordinary extent.

Without any further notice of facts that are common knowledge, an attempt can be made to solve the problem. It is merely a question of specific gravity, and the methods by which this is at the will of the bird. Gätke, in a well-known paper, attempted to deal with the matter this way, but his essay was not a happy one. For one thing, he guessed the bulk of a Great Northern Diver to be about one cubic foot! He knew the weight of a foot of North Sea water to be sixty pounds, and a very little trouble would have shown him that the bulk of a big Great Northern Diver was not the third of a foot.

I am enabled to give the exact bulk of a few typical water birds. The cubic content of a Black-necked Grebe weighing ten ounces was 25·3 in.—roughly speaking, the sixtieth part of a foot. A Little Grebe of six ounces had a bulk of 13 in.; a Smew of fifteen ounces, 35 in.; a Mallard of two pounds, 198 in. All these calculations were made on clean dry birds, with the "feather film"—to coin a convenient term—unbroken. Students

of physics will remember that the surface-film of water is appreciably tenacious, and is with difficulty broken by a fine-meshed fabric. The water-repelling property of the plumage of such a bird as a Duck is attributed to the grease or oil on the feathers. This I find to be by no means always the case; the grease must play a very minor part indeed in the work of keeping the feathers dry. The experiment of washing the feathers of a Duck in warm soda water, and afterwards with benzine, so that all trace of oil is removed, proves that the power lies in the actual structure of the feathers. The parts employed are the cilia and barbicels normally, the modified barbules frequently, and the hamuli (when present on the contour feathers) also frequently. I may be allowed to point out that this use of these feather elements has not before been noticed; and I think that without their aid existence under present conditions would be impossible to most birds.

I have termed this outer mesh of barbules, and the pile of cilia, the "feather film." It is hardly correct to say that when a bird gets wet the water penetrates the feathers; as a matter of fact, it is the other way about—the feathers penetrate the water! As long as the tough surface-film of the water remains intact, the feathers will remain dry, and the fine pile of the cilia and barbicels, only to be detected by the microscope, keeps the water from the coarse touch of the harder parts of the feathers.

Between this "feather film" and the skin of the bird there is a thick layer of air, varying in quantity according to circumstances. In a clean and dry Black-necked Grebe I ascertained it to be 4·8 cubic inches. In life this aerial envelope could have been considerably increased at will. Each of the contour feathers is provided with a separate apparatus of muscles, whereby it can be held out at right angles or pressed close to the body. In the first case the bird would appear round and fat, in the second very slim, and there would be a corresponding change in the extent of the air-envelope, and consequently of the buoyancy of the bird. By adjusting the thickness of this layer of air between the "feather film" and the epidermis the bird can alter its specific gravity; and here, I think, we have the answer to the riddle.

I have made a great number of careful observations, calculations, and experiments on various species of birds, but I hardly think it necessary to take more than a single instance, and that the Little Grebe. The Lathkill and several other of the neighbouring Derbyshire streams provided admirable conditions for making the necessary observations, and for checking the experiences of other districts. When a family party dozing in the middle of a pool was alarmed, they all disappeared below the surface and remained submerged, with the exception of their heads or bills. I was not able to be sure how they held themselves below the water, but see no reason to doubt that use was being made of the rank vegetation—probably by the inward pressure of the flexed toes, as I have described. Yet this detail is not of great importance.

In time, if reassured by the stillness of the intruder, the Grebes would appear again, but very gently and unobtrusively, and in a while they would take up their positions at the surface, perhaps in the centre of the pool, away from the vegetation. It was easy to watch the slow transition from a state of total submergence—so far as the body was concerned—to one where the birds floated, balls of feathers, high on the water. Those familiar with Grebes (or almost any other species of water birds) must have noticed this occasional habit of floating nearly as lightly as a Gull.

At each distant alarming sound the Little Grebes would drop suddenly deeper in the water, the degree in the change of draught varying with the source of the alarm; and when danger seemed imminent, and the birds dived, a preliminary drop in the water indicated a sudden change in the specific gravity. The Moorhen acts in the same way when alarmed, but this instinctive feather adjustment, for another purpose, however, is seen most prettily in its relative, the Water-Rail; at each forward step, if only for a couple of inches, the flank-feathers are automatically pressed close to the sides, so that a cross section of the body would give not a circle but a long oval. This is connected with the Rail's miraculous facility for passing rapidly through tangled herbage.

The following results of experiments and calculations made on a freshly killed Little Grebe support the conclusions based on

those made with other birds. The absolute specific gravity of this specimen was ·86. While dry and clean, with plumage unruffled, and the aerial envelope kept as large as possible, it was ·66, and with the feathers carefully bound down with fine yarn in as natural a manner as possible it was ·84. The actual loss of bulk between the two conditions—with feathers held out and with them depressed—was 2·24 cubic inches. Of course, the whole of this air is not available for lifting the bird in the water, but I see no way of measuring the exact amount of the effective air, and must be allowed to guess that at least one full inch can be used. The increase in buoyancy due to the addition of one cubic inch of air to a body six ounces in weight must be very considerable, and quite enough to cause the alterations in draught that we observe in the living bird.

Some observers have thought that the air-sacs play a part in the submergence of water birds. I cannot think this is so. In a dead bird the amount of air in these rarely examined reservoirs is very small, as may be seen by opening them under water, and the structure of the body prevents the bird increasing this quantity to any useful extent; and, it will be remembered, the volume of air would bear but a small proportion to that of the aerial envelope outside the epidermis and within the "feather film." Observations seem to show that the syrinx of a Little Grebe is too small to allow the escape of a sufficient quantity of air to cause the sudden difference of draught in the alarmed bird.

There are many minor points that will be noticed by a thoughtful observer, but I do not think it is necessary to detail them here. An alarmed bird lifts its heavy head and neck right out of the water, thus destroying the large reservoir of air round the crook of the neck, and throwing additional weight on the floating body—just as an uplifted arm will press a swimmer deeper in the water. The actual shape of the bird is also important, but I am sorry to say that I have not been able to make any reliable experiments. When a diving Duck is standing on the land (a Pochard was an excellent example) it exhibits a broad and flat keel, and is obviously farther through from side to side than when it is diving. This is an important

item, for a flat-bottomed vessel floats higher than one of the same weight with a deep and narrow body. Of course, the Duck can alter the outward shape of its waterproof "feather film" at will.

I offer the above remarks as an attempt to solve a problem that has for long puzzled ornithologists. I have explained how a Grebe may use its clumsy toes, and how a Moorhen actually does use them; indicated the use of the cilia and other feather elements in keeping the plumages of *all* birds waterproof, and showed that this power is not dependent on the grease. Finally, I point out how the actual submergence of a swimming or floating bird is due to the height of its specific gravity, and how this is readily adjusted within the necessary limits by the voluntary act of the bird.

NOTES ON THE BREEDING OF THE GREAT TIT (*PARUS MAJOR*, Linn.).

By C. Kingsley Siddall.

The usual time for the breeding of the Great Tit is from the middle of April onwards. The pair under notice commenced to build on the last day of April in a box which had been placed for the purpose in an apple-tree.

The nest was a typical one, composed of moss and a good deal of red wool which had evidently been torn from an old mat. It was warmly lined with wool and hair. Both birds took part in building, and finished the nest on May 4th. The first egg was laid on May 5th, and on the 12th the female began to sit on a clutch of seven. She sat extremely closely, and often refused to move when the box was opened. This was done very frequently, in the hope of finding the male bird sitting. He was never discovered doing so, and, indeed, visited the nest seldom in the daytime during incubation, though he always roosted in the box at night. He was not observed to carry food to the sitting female during this period.

Some days before the young were hatched, a camera was placed in position, with the result that the Great Tits became accustomed to the sight of it, and photography (with a twenty-foot shutter release) became a fairly easy matter. A hiding-place was arranged, eighteen feet from the camera, from which the exposures could be controlled, and with a pair of binoculars any known species of larvæ could be readily recognized when the parents came to the nest.

On May 24th seven young birds were safely hatched; in appearance excessively ugly, the only covering on their otherwise naked skins being a suspicion of down on their skulls and shoulders. The legs and claws looked much too strong for the rest of their bodies.

On the fourth day there was down on the dorsal tract, and signs on the wings of the coming pen-feathers. On the sixth day the bluish tinge was noticeable. The tail-feathers could not

be seen until the tenth day. The first nestlings had their eyes open on the eleventh day.

On the fifteenth day a curious incident occurred—the female laid an egg on the young birds! When twenty-one days old the nestlings were fully feathered, and two days later they left the nest.

On leaving the box the old birds usually carried out the fæces of the young, and dropped them a short distance away; apparently the fæces were never swallowed by the parents. It is an interesting point to observe that, although the nest is kept

YOUNG GREAT TITS, TWENTY-TWO DAYS OLD.

clean in this way, it is very full of vermin. Why do these insect-eating birds leave these untouched? The food carried in to the nestlings consisted almost exclusively of small moth larvæ.

About thirty yards from the nest there was a small spindle-tree, which was at this time literally covered by the larvæ of the Small Ermine Moth (*Yponomeuta padella*). For the first sixteen days the Great Tits made no attempt to take these caterpillars. Probably they were afraid of the web-like material which surrounds the larvæ of this species.

On the seventeenth day the male bird was seen to be carrying a grub which had not previously been observed. The camera-shutter was released with a crash as he was about to enter the box, and in his fright he dropped the caterpillar, which on examination proved to be that of the Ermine Moth. Having found they could take them with impunity, the Great Tits made short work of these garden-pests, for, until the young left the nest, the birds went backwards and forwards constantly between the spindle-tree and the box. On counting they were often found to be paying four visits in five minutes. Frequently the female would arrive with food before the male bird had left the box, and *vice versa*.

An interesting difference in the behaviour of the sexes was noted. The male bird invariably used the perch in front of the box before entering. He would cling to it with his claws, while he looked from side to side. In this position he was easy to photograph. The female never used the perch; she would alight on a branch in front of and a little above the box, and would drop right in, merely touching the edge of the hole with her feet as she entered. Several plates were exposed with the same result, a view of her feet and tail being obtained each time. Apparently it was not nervousness which accounted for this, as the bough of the apple-tree she used to alight on was barely two feet from the camera.

The larvæ of the following insects were taken as food:—Small Ermine Moth (*Yponomeuta padella*), Winter Moth (*Cheimatobia brumata*), Magpie Moth (*Abraxas grossulariata*), Cabbage Moth (*Barathra brassicæ*), Sawfly sp. (*Nematus ribesii*). There were three nests of Humble Bees (*Bombus* sp) close at hand, but the Great Tits made no attempt to take the bees. There is no doubt that the birds will take any small larvæ as food, and the species mentioned above happened to be the commonest available near the nest.

The Great Tits undoubtedly do much more good than harm in an orchard or garden; the foregoing short list is composed entirely of injurious insects, and the Small Ermine Moth in particular is a most destructive species. It is rather curious to note that no beetles or flies were taken, the explanation probably being that more palatable food was plentiful.

On June 17th the young birds left the nest. It will be thus seen that five days were spent by the old birds in building the nest, seven in laying, twelve in incubation, and twenty-three in rearing the young. Contrary to expectation, the Great Tits did not use the box for roosting at night after the nestlings left it.

On the day of flight the seven young were seen at intervals following the parent birds from tree to tree. Food was still carried to them, and it was a pretty sight to see them feed. On June 21st two adults and five young Great Tits were seen, close to the box, searching for food in the fruit-trees, and now the young were making efforts to find their own food.

On June 26th the same numbers, and almost certainly the same birds, were observed in the orchard, but after that date no *family* of Great Tits was seen in company, although numbers of young and adult birds were common through the summer. This would rather point to the breaking up of the Great Tit family much sooner after the nest is left than is the case with its relation, the Long-tailed Tit (*Acredula caudata*). Families of this species are known to keep together months after leaving the nest.

It is perhaps worthy of note that the eggs in this nest were left uncovered until the female began to sit; often the Great Tits cover their eggs with feathers or wool when leaving the nest, and continue to do so till the full clutch is laid and incubation begins.

THE FORMATION OF USELESS HABITS IN TWO BRITISH NEWTS (*MOLGE CRISTATA*, LAUR., AND *M. PALMATA*, SCHNEID.), WITH OBSERVATIONS ON THEIR GENERAL BEHAVIOUR.

BY BRUCE F. CUMMINGS.

(Concluded from p. 175.)

V.

MY conclusions are :—

1. That Newts, in a labyrinth, rapidly acquire simple habits of movement. Plasticity is shown, for these rapidly acquired habits as rapidly disintegrate and become re-acquired, although the acquiring of a habit takes longer than its re-acquirement, after short intervals from about twenty minutes.

2. On account of the Newt's plasticity, a simple habit can be "forced" in a short space of time by frequency of stimulus.

3. The plasticity must again serve to account for the large number and elaboration of useless habits formed, from which no pleasurable result accrued.

4. A movement, once made, tends to be repeated. Apart from useless habits, I observed throughout how frequently quite insignificant and useless movements were carried out twice in succession, or sometimes three times.

5. Motor sensations are chiefly used in learning the labyrinth. It "feels" the direction in which to turn (and in which it has previously turned) through the effects of previous muscular sensations. Touch also helps, but sight only a little.

6. The strong "nosing" instinct or stereoscopic reflex can be partially inhibited, and a perfect habit temporarily formed.

I have given in the preceding pages some of the most interesting and the most typical examples of behaviour that I observed. All the other experiments with the rest of the Newts confirmed the conclusions above, but none of the animals, of course, succeeded in learning the more complicated mazes per-

fectly or permanently, for the same reason given for the others —nosing and climbing impulses.

VI.

It seems not improbable that the evolution of the capacity for habit formation has taken the following stages:—

1. Where there is no modifiability of behaviour.

2. Where modifiability does exist, but in only a slight degree, so that habits become formed only after a long period of "stamping in." On account of this protracted period of "stamping in," useless habits cannot be reduced, and therefore correct habits are not formed, although roundabout methods of solving the problems presented are adopted.

3. Where there is rapid modifiability, succeeded by a more or less rapid reduction of useless habits. The very fact of rapid modifiability makes reduction possible. But rapid modifiability, in its inception, consists of the tendency mechanically to repeat movements from which pleasure need not necessarily result. Thus a large number of useless habits would make their appearance, and the first solution of a problem would be a very roundabout one. Subsequent experience would reduce the number, and different animals, varying in intelligence, would vary in the rapidity with which they were reduced.

4. Where a keener consciousness and a more acute intelligence means rapid modifiability, but, more particularly, few useless habits, as only movements ending in pleasure would tend to be impressed on the nerve centres, and therefore to be repeated. The relative intelligence of different animals in this category would depend upon the rapidity of their perceptions of those movements most conducive to pleasure, *i.e.* upon the paucity of useless habits formed in the first instance.

5. Where, finally, modifiability is more or less immediate, through the presence of the memory idea, absent in the others.

The first class is perhaps hypothetical, perhaps the Crab belongs to the second, while the third class is represented by the Newt, the fourth by the Pigeon, and the last by Man. All these animals have had their learning powers tested. This course of development would involve the formation of useless habits, not as a freak of intelligence, but as a natural sequence in the order of

things. In an animal with a low intelligence, such as the Newt, useless habits are very clearly demonstrated by the labyrinth method, where, on account of the Newt's plasticity, movements tend to be repeated; useless habits are thus formed, and the first solution of a labyrinth problem is a roundabout one. But there is also reduction—the complement of rapid modifiability—so that this animal, which has such blunt perceptions, is able by a process of mechanically building up and then cutting down to form a more or less perfect habit.

The examples of useless habits which I have given were all extraordinary, and were described in order to show that there does exist mechanical repetition of useless movements.

Prof. M. F. Washburn records* that in the case of some Salamanders tested by her in a labyrinth, the animals never learnt the maze properly, but formed many elaborately useless habits. The motive employed was not satisfactory, and the experiments were not therefore completed. It is, however, interesting to note that the appearance of these elaborately useless habits have been corroborated by my experiments with Newts. Useless habits of a lesser degree have been also reported in other animals.

What conclusion is to be drawn from a consideration of the Newt's tendency to repeat movements is difficult to see. The observations made on the Newt, especially when in the spiral labyrinth, showed that movements undoubtedly tended to be repeated, irrespective of consequences. The animal went continuously right or continuously left of the pillar, though both were equally correct. It might be supposed, therefore, that the repetition of these turns is largely mechanical, and only very indirectly dependent upon conscious choice. If the Newt simply chose the directions leading to pleasure, it should on the average have gone alternately right and left of the pillar of the spiral. In other labyrinths many useless habits were formed which led only extremely indirectly to pleasure. It is possible that this tendency under certain conditions to repeat movements indiscriminately is mechanical. Such a mechanical tendency could be acquired if useful. Its usefulness to the animals when in a state of nature is quite inconceivable, and if mechanical,

* 'The Animal Mind,' p. 231.

the movements must therefore be repeated through some unknown and wholly adventitious nerve mechanism, which seems impossible. The explanation of useless habits as they occur in the Newt and other animals probably lies in the nervous inertia of these animals. They prefer, when hard pressed as in a labyrinth, to repeat an old movement rather than seek out new and more appropriate ones. We can observe not an exactly parallel but an analogous case where a man in a labyrinth, out of which he had not found the way, would, in wandering up and down the passages, form after a time little habits of movement that would save him mental exertion.

PART 2.

VII.

In attempting to form an opinion on the general psychology of the Newt, it is necessary to take into consideration the various chapters in the story of its life. There is one which stands out in particular, amid its general amphibian sluggishness, as proof of an unexpected amount of nervous activity stored up in the brain which only develops periodically—I mean its courtship displays in the spring. In the Palmate, for example, the male assiduously follows the female about, taking advantage of every opportunity to display. Its display attitude is well known—curved body, hollowed-out, cavernous side on the inside of the curve, and the rapidly vibrating tail and caudal filament. The whole aspect of the animal is one of extreme activity and nervous tension, which, occurring as it does in a Newt, is thoroughly surprising. This excitement expends itself along the easiest line by travelling into the tail, which is so easily swept from side to side, or vibrated. Most courtship displays can be explained in the same way as a matter of accident. In the case of the Great Crested Newt a gradation is found, leading up to that which obtains in the Palmate. The Great Crested does not bend the tail back flat along the side, and rapidly vibrate it; it merely waves the tail like a happy dog or an angry cat. Its excitement is less than the little Palmate's.

The handsome and distinguishing features of the male Palmate all lie along the sides of the body, one or the other of which is always turned towards the female during courtship displays. It

is a curious fact—to sexual selectionists a very useful one—which I do not think has been pointed out before, that—

1. The displays invariably take place at the front end of the body of the female Newt where she can see them.

2. The tail is invariably vibrated on the side which is facing the female. If, in the middle of a display, the female so moves as to be able to see only the other side, the male stops vibrating its tail, unbends it, and turns it round to the other side, where the vibrations are re-begun.

That the Newt possibly recognizes the female only by sight is shown by the following circumstances: I had in the same basin, with healthy males and females, two unhealthy males, which had developed only to a very slight degree the usual sexual adornments. In fact, they looked very much like females. On two occasions a male—a different one each time—came and displayed before these males, which they obviously mistook for females. As I shall emphasize later on, the frequency with which Newts are deceived by appearances is a marked feature. I have also watched ecstatic little males displaying to a female while the latter was in the act of laying an egg.

The female remains quite passive throughout; if she is willing to be fertilized, her willingness is indicated by a hypnotic stare; she remains motionless long enough for the male's excitement to reach its flood, when the spermatophore is dropped. Whether the motion of the tail has any fascination for the female it is difficult to say, but it is worth remembering that Newts are exceedingly quick to observe motion, and are often deluded into snapping at moving objects in mistake for food, while other motions they will watch attentively for minutes at a time. Whatever be the feelings of the female, no one can help being astonished at the abounding energy and enthusiasm of the little male. I have seen it, in a paroxysm of sexual excitement, bend and vibrate its tail, hollow out its body, and lift the whole of its hind quarters and legs off the ground, so that it assumed the appearance of standing on its head. There is no such behaviour in the Toad or the Frog to compare precisely with this, as the tetanic contraction of the muscles of the fore legs of the Toad on the abdomen of the female, if roughly equivalent in the amount of energy required, is not so spectacular as the Newt's

performances, and necessitates less mental activity and alertness.

VIII.

As to parental instinct, the Newts show a distinct advance on the Frog and the Toad. In the Palmate Newt the leaf of a water-plant is clasped by the hind feet of the female in the well-known way, and after the deposition of the egg the leaf is bent back and round the egg, and secured by a sticky gland secretion. Such a mode of egg-laying means that a less number of eggs can be laid, for, in the place of the mechanical reproduction of a large number of eggs, we have the careful concealment of a relatively few, *i. e.* reproductive activity is in part turned over into mental activity. It is shown on all hands by a study of comparative psychology that our system of zoological classification is even more arbitrary than there was any reason to expect. In placing the Bee, for example, in a position so far below the Newt, zoologists are only taking into consideration one or two morphological points, such as the occurrence in the Newt of a backbone and in the Bee of a tracheal system. Yet it must be admitted that from the wider standpoint of general but more particularly nervous organization the Bee, albeit on a different branch, stands as high on the Tree of Life as does the Newt. The convenience of our classification is very great, but it is apt to lend us a distorted view of the actual relations between different animals. Because man has a backbone, we are too disposed to think that any organism without one must be a "lower animal." The brain of the Newt can only be considered higher than that of the Bee in reference to its form, the mould in which it is cast.

IX.

An account of the mental characteristics of the Newt would be very incomplete which did not refer to its feeding habits and its astonishing voracity. As a rule a Newt will not eat a dead and motionless worm, not, I think, because it is dead, but because it is motionless. I made a few observations on the behaviour of some Great Crested Newts, when presented with some dummy worms made of putty. If the dummies be motionless at the bottom of the pan, no notice is ever taken of them. But if I took hold of the end of one by a forceps and waved it

about so as to imitate the motions of the worm, the attention of the Newts was immediately called to it. A large female accepted the dummy and the real worm in the following order :—Dummy, worm, dummy, worm, dummy, worm, dummy, dummy, worm, after which it refused dummy. The next day it went : dummy, worm, after which dummy was refused. After it had been offered dummy four more times it grew to take no interest in it, its motions not attracting its attention in any way. A real worm was then offered the animal, which it immediately seized with avidity. A dummy was then offered again, and it seized it quickly, but dropped it again, and after, although it went on accepting the worms, it continued to refuse the dummies.

The dummies were twice as big as the worms. The Newts paused longer before snapping at a dummy than they did before a worm, except in the above case, where it was quickly seized and as quickly dropped. This shows that the Newts are able to distinguish a difference between worms and dummies, but that they are sufficiently deceived by appearances to be induced eventually to snap and swallow. I found the same animals would follow about a piece of bent wire, and one of them even snapped at it, but this animal may have been *more than usually hungry*. One of my Cresteds, after living in one of my pans for six months, died of starvation, on account of an obstruction of the rectum, which, on dissection, was shown to be caused by a small quantity of earthy matter and seven caddis-worm cases, with remains of their putrefied occupants. The earthy matter was of the same material as the cases, and probably represented at least another caddis-worm case, making eight in all. The rectum was distended to bursting point, and the other organs displaced. The species of caddis-worm was a very common one in the pond when the Newt was taken, at which time it was first observed to be suffering from what I thought was a tumour.

This is easily explained if we bear in mind the Newt's readiness to snap at moving objects. Palmates are great adepts at snapping at almost microscopic organisms as they rush past. Another Newt, which I tried, drove me to the conclusion that either it was a mental wreck or else had developed a taste for

putty! It snapped and swallowed a small piece six times in succession, and snapped at it twice after, making eight in all, after which it refused the dummy, although taking the worm. The front legs are never used in feeding as in the Toad.

It is worth remarking that by some means or other the Newts in a pan of water, which have not themselves noticed the presence in the water of a worm, nevertheless frequently appear to realize it immediately, as soon as another Newt has seized the worm and given it the usual shake from side to side—a useful instinct which prevents the coiling of the worm around the Newt, and which is given also with dummies, but not with animals other than worms. A sense of taste very probably exists, as I have seen an empty Newt sometimes come up and place its lips against those of another which had just swallowed a worm, and afterwards show by its tendency to snap at its comrades that it knew there had been food about.

X.

A Newt, on arriving at the edge of a square board raised above the ground, as a rule stops and pauses before throwing itself over. I discovered that at heights of 180 centimetres and upwards the Great Crested generally refused to go over, after hanging over the edge and looking down to the ground beneath, which in all these experiments was covered with a dull brown cloth. Some animals would go over at any height, others would show great hesitation at the 180 centimetres, eventually slipping over—it was difficult to tell whether by accident or intentionally. If the Newts are in a hurry, or in a state of excitement, they rush off at any height. Similarly with three Newts which were extremely lethargic through hybernation. It is interesting to observe that in the case of fifteen *M. cristata*, which, in the beginning of September, were removed from water to a vivarium, the heights at which they would throw themselves over the edge of the board varied in inverse ratio as the length of time that they had been removed from the water. After being in the dry box for forty-eight hours, 60 centimetres was refused by nine to six. After ninety-six hours only two went over. On the fifth day five refused 6 centimetres. On the next day nine refused 15 centimetres, two refused it at the first trial (going over sub-

sequently), and only three went right over at the first time. Several days later I found that three of the Newts refused to leave the board, when it was placed on the floor of the room, so that the height was only the thickness of the board, *i. e.* 2 ctim. 2 mm. One of the three perceived the edge when a couple of centimetres away, and would draw back. However, when placed immediately after on a piece of cork matting only 8 mm. thick, they all three went over, but only after a pause of ten seconds in two of the cases and eight in the other! The rest refused a height of 15 ctim. by eight to two.

By experimenting with these Newts, when in this condition of refusing low heights, I thought to be able to discover whether they had any elementary power of judgment of height. The results showed that they can recognize extremely low heights (as might have been expected) up to between 5 and 8 ctim.

The Newts, in all the experiments, were tested singly and in series. Below are some of the best instances in which a Newt showed its disinclination to go over 180 ctim.

Singly: 1. 60 ctim. refused after pause of 75 seconds.
2. „ „ „ 30 „
3. 20 ctim. „ „ 30 „
4. „ went over „ 18 „
5. „ „ „ 20 „
6. „ „ „ 10 „
7. 60 ctim. „ „ 10 „
8. 180 ctim. refused repeatedly, walking on the board for five minutes.
9. 60 ctim. went over after a pause of 50 seconds.

This shows how easily previous behaviour influences the Newt, not, however, completely in the 180 ctim., although the pause at the next drop of 60 ctim. was increased. Another animal gave :—

1. 60 ctim., over after 30 seconds.
2. „ „ 20 „
3. 90 ctim., over immediately.
4. 180 „ refused repeatedly.
5. 60 „ over after 60 seconds.

In series : 30 ctim., thirteen went over and five refused.
80 ,, eleven refused and five went over.
30 ,, eleven went over and six refused.

If the animal is able to judge when it is as high as 180 ctim., as the evidence points, it probably does so by sight. All the animals, if hesitating, spent their time in looking down and around. At 180 ctim., perhaps, they are able to see nothing at all beneath them. In the middle distances they can see the floor, and therefore fling themselves over when in normal condition, but no judgment is formed as to the varying height of these middle distances. The low heights they are perhaps able to see distinctly, and therefore to form an elementary judgment.

In such a slight power of judgment we see something upon which the forces of evolution could act, if necessary. But the fact of the matter is that, so far as I am able to understand the Newt's feeling by observing its outward actions, a fall of 180 ctim., even when repeated several times in immediate succession, has no effect upon it, except perhaps a little temporary discomfort.

The hopping Frog has to take "pot luck" as to where it is going to land itself, and there is, of course, no hesitation in that animal in jumping over a precipice, if one got in its way. The Toad, if it is crawling, is always brought to a standstill by the edge of a board. It is curious to observe in this animal, and more especially in the Newt, how frequently it went to the edge of a board without realizing it until the non-contact stimulus of one of its feet attracted its attention, and it immediately looked down.

It has been shown* that land-dwelling Tortoises crawl over 30 ctim. without reluctance. Water Tortoises plunged off without hesitation, but at a height of 90 ctim. hesitated slightly. Amphibious Tortoises hesitated at 30 ctim., and at 90 ctim. showed more hesitation and reluctance.

XI.

The Newt, in both species, has a strong stereoscopic reflex. It is surprising to observe the strength it is able to employ in

* Dr. Yerkes : "Space Perception in Tortoises," 'Journal of Comparative Neurology and Psychology,' vol. xiv. p. 17.

forcing itself under a flat stone. If, in the autumn, a few Newts be left in a large box, which is perfectly empty, they will be found in a very short time together in a large heap, each Newt having come along and thrust itself in under another, until those originally on the bottom of the box become raised to the top of the heap. This observation probably explains the fact that Snakes and Frogs have been found, during hybernation, around each other in a mass.* Whether Newts hybernate sometimes in this way I do not know. The flat nose of the Newt never fails to respond to the stimulus of contact with one surface applied to another so as to leave a suitable crevice.

The tail is used efficaciously as a prehensile organ, but the action of the tail resembles the stereoscopic reflex, as it is an instinctive response to surface contact, for it is seen that, while it apparently with intelligence hooks the tail around an object, it shows in the matter of unhooking a remarkable absence of intelligence. I have seen it struggling to walk forward in vain for minutes at a time, simply because its tail was coiled around an upright post. The fore legs are never used to hold food, and can be only very roughly employed to scrape acid or other stimulus from the head.

Newts, in captivity, soon lose their natural wariness. The commotion at first caused among freshly captured Newts in a tank when someone approaches soon ceases after a short period of captivity.

The Newt's persistency at all times strikes the observer, but the use of such a descriptive term applied to the Newt is very misleading, as it signifies conscious determination to overcome a difficulty which it at least partially understands. The Newt's "persistency" is a recurrence of the already mentioned tendency to repeat an action over and over again. It is an expression of the superiority of its bodily activity over the activity of its cerebral cortex.

In its primary instincts—those of breeding and feeding—the Newt has been shown to display a certain impetuosity which is significant when compared with the usual monotony and sluggishness of the Newt's existence. But this very impetuosity—an

* Dr. Gerald Leighton's 'British Serpents,' p. 60.

advance as it is on the Common Toad and Frog—only serves to show the bluntness of its perceptions.

The mother-liquor, from which all distinctive traits of animal intelligence crystallize out, is a combination of variety of experience and individual mental variation which are largely absent in the Newt. Only a strong effort of the imagination, after a careful, first-hand study of the behaviour of Newts, can conjure up in our minds a comparatively truthful picture of the dreary monotony and automatism of the life of the Newt as a whole. Such a picture, it is needless to point out, is very different from those glowing accounts of the romance of animal life presented to an innocent public in many of our English magazines. There is no harm in these stories if they are honestly given their correct designation—fairy stories. But the pity is that their authors palm them off as Natural History.

RECORDS OF SOME SCANDINAVIAN WOODLICE.

By Richard S. Bagnall, F.L.S., F.E.S.

In June, 1909, I had to visit Norway on business, and took the opportunity of extending my journey to Sweden and Denmark. Whilst most of my time was devoted to business matters, I spent several happy hours collecting in the neighbourhood of Bergen, Arendal, and Christiania, in Norway; Gothenburg, Sweden; and Copenhagen, Denmark, taking a Springtail and two or three Thrips new to science. I casually met with a few Woodlice, and as *Trichoniscus roseus*, Koch, and *Armadillidium nasatum*, B.-L., have not before been recorded from Norway or the latter from Denmark, whilst *Haplophthalmus mengii*, Zadd., *Trichoniscus pygmæus*, G. O. Sars, *T. roseus*, Koch, *Philoscia muscorum*, Scop., and *Porcellio dilatatus*, Brandt,* are apparently new to the Swedish fauna, it is necessary to put the following on record. Had I been aware at the time that the Woodlice of Sweden were not well-known, I should have made a special collection in that group.

Haplophthalmus mengii, Zaddach.—Sweden: One specimen in the public gardens at Gothenburg, June 28th, 1909. An addition to the Swedish fauna.

H. danicus, B.-Lund.—Norway: One specimen in the Tiaenhavn Botanic Gardens, June 25th, 1909.

Trichoniscus pusillus, Brandt.—Norway: Common; Bergen, Stend, Os, Egersund, Fevig, Arendal, Sandviken, and Christiania. Sweden: Gothenburg. Denmark: Near Copenhagen.

T. roseus, Koch. — Norway: In the hothouse behind the Museum, Bergen, with *Armadillidium nasatum* and *Porcellio dilatatus*, June 19th, 1909. Sweden: Gothenburg, June 28th, 1909. Apparently new to both these countries.

* A. M. Norman, Ann. and Mag. Nat. Hist. ser. 7, iii. p. 78, January, 1899. I base my remarks upon a table printed in above paper written more than ten years ago. It is quite possible that the Swedish species have received some attention since then.

T. pygmæus, G. O. Sars. — Sweden: Gothenburg, with *T. roseus*. This minute form is now known from Norway, Great Britain and Ireland, Belgium, and Sweden.

Philoscia muscorum, Scop.—In some places plentiful amongst rank herbage and under stones in moderately dry situations. Norway: By the roadside between Fevig and Arendal, June 23rd, 1909. Sweden: Near Gothenburg. Prof. Sars has never met with this usually common form in Norway, and records but two specimens taken by the late Dr. Jensen; whilst it is apparently not recorded from Sweden. I feel certain that I also saw this species at Egersund, Norway, but there is no note to that effect in my note-book.

Oniscus asellus, Linn., and *Porcellio scaber*, Latr.—Common in all the localities quoted for *Trichoniscus pusillus*.

Porcellio rathkei, Brandt. — Denmark: Two specimens from under the bark of a log in a field at Ordrüge, near Copenhagen, July 1st, 1909.

P. dilatatus, Brandt. — Norway: A few specimens from hothouses at Bergen and at Christiania. Sweden: In the fernhouse of the Gardens at Gothenburg, June 28th, 1909. Only three specimens are recorded by Prof. Sars from Norway, whilst it is evidently not known from Sweden.

Metoponorthus pruinosus, Brandt. — Sweden: Gothenburg, with *P. dilatatus*.

Armadillidium vulgare, Latr.—Denmark: One specimen from Copenhagen.

A. nasatum, B.-Lund.—Norway: In hothouses at Bergen; a few specimens only. Denmark: Several examples in one of the hothouses of the Botanic Gardens, Copenhagen. *A. nasatum* has recently been recorded in great profusion from hothouses in various parts of the British Isles, whilst I have also recorded it from Belgium in similar situations. These are the first records from Norway and Denmark.

A. pictum, Brandt.—Norway: Several under the bark of an old lime-tree at Bygdo, near Christiania, June 27th, 1909. This species has not yet been recorded from the British Isles, but will almost certainly be found when more attention has been given to the group.

Since Webb and Sillem's 'British Woodlice' was published in 1906 a small band of workers have added considerably to our knowledge of the distribution of known species, and have made several interesting additions to the fauna, including *Trichoniscus pygmæus*, G. O. Sars (England, Scotland, and Ireland); *Armadillidium album*, Dollfus (Devon); *Eluma purpurascens*, Budde-Lund (Ireland); and four hothouse species new to science, namely, *Trichoniscus stebbingi*, Patience (Scotland, England, and Belgium), *T. spinosus*, Patience (Clyde), *T. linearis*, Patience (London), and *Philoscia patiencei*, Bagnall (London and Winlaton).

NOTES AND QUERIES.

MAMMALIA.

Stoats (?) attacking Lapwings.—At the end of November, 1909, and during the first week in December following, some mysterious animal, supposed to be a Stoat, killed quite a number of Plovers on Mr. Millard's farm at Hethel (which adjoins a farm of mine near Norwich). Mr. Millard picked up four Lapwings and two Golden Plovers, and his ploughmen found thirteen more. All of them are described as having blood on the head, otherwise not a feather was ruffled. The two last ones found, however, had been partially eaten by some creature.—J. H. Gurney (Keswick Hall, Norwich).

AVES.

Large Clutch of Eggs in Nest of Mistle-Thrush.—Whilst walking near the village of Hucklow, Derbyshire, on May 17th, I found a nest of *Turdus viscivorus* containing six eggs. The nest was unusually large, the eggs were in no way cramped for space, and all were of the same type and well marked. In my eight years' experience of the birds of North Derbyshire I have never known of six eggs in a nest of this species. I have occasionally found five eggs, but the usual number for this bird appears to be four. The nest was situated in the fork of an oak-tree.—J. S. Macdonald (Bretton Clough, Eyam, near Sheffield).

Strange Nest of Blackbird.—I have read with interest in several numbers of 'The Zoologist' accounts of peculiar nesting-sites of several birds. I had one brought before my notice the other day, which I think is worth recording. It was a Blackbird's nest built in a rhubarb-leaf, and the leaf was standing in its natural position. To keep the nest secure the birds had pierced holes in the leaf, and woven pieces of dry grass round the ribs of it. The nest was very roughly made, there being no lining of fine grass as is usual with the Blackbird, but just a rough lining of mud. It contained three eggs, which were unmistakably those of a Blackbird, and not of a Thrush. It may also be of interest to state that I saw a pair of Hobbies flying quite close to me on May 22nd, and these are the first I have seen in this neighbourhood.—A. W. Ecutt (Commercial Street, Newport, Mon.).

Late Stay of the Fieldfare.—On May 17th I observed a single Fieldfare (*Turdus pilaris*) flying over the Thanet Golf Course. The weather was thick at the time, and the bird had evidently lost its way, for it was calling repeatedly, and making in a southerly direction. This is, I believe, the latest record for Kent.—COLLINGWOOD INGRAM (Westgate-on-Sea).

Observations on the Nesting of Rooks.—In 'The Zoologist' for 1904 (p. 191) I contributed some observations on the efforts of a pair of Rooks (*Corvus frugilegus*) to build a nest some little distance from the main rookery. Several equally unsuccessful attempts have been made in the meantime. This year, however, six pairs succeeded, after a certain amount of hostility from the main body, in completing their nests, and, as I could watch from my windows the old birds sitting on the nests, I have little doubt that the full complement of eggs was laid. For some reason which I am quite unable to explain, not a single young bird has been reared in any of these nests. I began to suspect some little time since that all was not well with the little colony, as one or two of the nests appeared to be deserted, and I examined the ground below to see whether I could find any traces of their having been disturbed, but there appeared to be nothing unusual. Once or twice when the birds were sitting I noticed a number of Rooks perched on the adjoining trees; they did not seem to be over-friendly, but I did not witness any act of aggression. There has been no failure of young birds in the large rookery; in fact, we have shot more than usual. Following the previous destruction of nests whenever an attempt has been made to establish an outlying colony, the facts appear to be very extraordinary.—R. H. RAMSBOTHAM (Elmhurst, Garstang).

Stone Curlew (Œdicnemus scolopax) in Bedfordshire.—This bird was observed by a friend and myself at Sandy on May 15th last. It was frequenting an area of market-gardening land between the roads leading to Everton and Potton, and what was formerly a portion of Sandy Heath. At this date it was more probably a wanderer from some other locality than a belated migrant resting on passage. Years ago the Stone Curlew nested not uncommonly on the Downs on the southern portion of the county, but the last nesting on record was about 1890, when two young that had a quantity of down still adhering to their feathers were shot between Luton and Dunstable. Since then but two other county occurrences can be given of this bird—one in 1894 was killed near Dunstable, and another, which I saw in the taxidermist's hands, had been killed from a ploughed field on

Nov. 3rd, 1904, at Haynes. — J. Steele Elliott (Dowles Manor, Salop).

Sandwich Terns and White Wagtails in Ireland. — For several years past, while residing at Moy View, Co. Sligo, I regularly kept a record of the dates of the spring arrivals of the Sandwich Terns to Killala Bay, and of the *Motacilla alba* to the island of Bartragh, but having left Moy View and come to reside at Ardnaree, Monkstown, Co. Cork, my friend Captain Kirkwood, of Bartragh House, has kindly undertaken to regularly keep up the future record of dates, and I now give some extracts of his notes for this season. To begin with the Sandwich Terns: they were unusually late; none were observed until April 27th and 28th, although some years ago I observed them in the bay and estuary as early as March 20th. My records from 1851 show that there were twenty-one arrivals in March, *viz.*: 1852, March 23rd; 1854, March 21st; 1856, March 20th; 1877, March 29th; 1880, March 24th; 1881, March 31st; 1882, March 30th; 1885, March 30th; 1886, March 25th; 1887, March 28th; 1889, March 19th; 1890, March 15th; 1891, March 28th; 1892, March 27th; 1893, March 23rd; 1894, March 27th; 1895, March 30th; 1897, March 22nd; 1898, March 31st; 1899, March 26th; 1907, March 24th. It would be interesting to know (now that watchers have been placed at the English breeding haunts) whether the Sandwich Terns arrive at their breeding haunts as early as they do at their Irish haunts, and being such early breeders that I have seen fully-fledged birds with their parents on the estuary as early as June 23rd. The White Wagtails visited Bartragh in unusually large numbers this season, and, owing to the long continuance of north and north-westerly winds, their resumption of their northern flight was delayed until a favourable change of wind to south permitted it. The first arrival of the advance guard was headed by a pair seen on the 5th inst.; afterwards single birds began to drop in, and on the 8th a flock of five birds was seen. Next day several more were observed, and on the 12th a flock of twenty-five birds; some of these left, but on the 14th twenty-two were counted about the marshy pasture (their usual haunt). However, as the wind was changing to the south, by the 19th only a solitary individual remained on the island. During the migratory season, if the winds are blowing mildly from the south and west, very few birds drop down on Bartragh to rest, but the strong north and north-westerly winds always delay their northern flight, and they then make Bartragh the resting-place until the wind favours.— Robert Warren (Ardnaree, Monkstown, Co. Cork).

Terns feeding upon Sticklebacks.—In some of the dykes in Holland Sticklebacks abound. I repeatedly watched both Black and Common Terns fishing for them and feeding upon them. — R. FORTUNE (5, Grosvenor Terrace, East Parade, Harrogate).

Large Clutches of Eggs.—During a recent nesting excursion to Holland, I saw an Avocet's nest containing five eggs, a Godwit's with six eggs, and a Redshank's with six eggs. The Godwit had four eggs when we first found it, the additional two eggs being in the nest when we visited it three days afterwards. The probabilities are, of course, that two birds laid in the same nest, though this was not very apparent, and there should be no reason for it, for upon the vast area of polders nesting-places are of course abundant. On May 28th, in a nesting-box at Harrogate, I found a Blue Tit sitting upon seventeen eggs. This box is fixed in an oak-tree in the centre of a large wood, and is about twenty-five feet from the ground. We have a few boxes about, and they are all tenanted by Blue and Great Tits. A neighbouring box contained a Great Tit's nest with one egg, and the female dead upon the nest, egg-bound.—R. FORTUNE (5, Grosvenor Terrace, East Parade, Harrogate).

A Note on Bird-Life in the Spessart.—A few notes on the birds observed during a journey on foot through this district, in the company of a German ornithologist, may be of interest. The notes were made between March 24th and 28th, 1910, at which date some migration was apparently in progress. The Spessart, I should state, is a forest district in the north-west corner of Bavaria, about thirty or forty miles from north to south, and rather less from east to west. It is bounded on three sides by the River Main, which makes a deep bend. The forest consists of oaks, beeches, and conifers. The highest points are about two thousand feet high, and are densely wooded. The valley of the river is cultivated for a mile or two on either side of the meadows, which abut on the swift gliding stream. Bird-life was very abundant, though the total number of species was not large. The most interesting and characteristic birds of the forest are probably the Great Black Woodpecker, the Kite, and the Buzzard. But it will be better to go through the list in order. There were a few Mistle-Thrushes in the forest, and song-Thrushes were rather more numerous; the last species, I was told, being only a summer visitor. Blackbirds were quite absent from the forest, but I saw a few in the village gardens in the Main Valley. On the evening of March 27th I heard the first Chiffchaff singing feebly at Wertheim, and on the two following days, as we walked down the valley, they were singing in their

hundreds. The weather was warm, and it seemed that migration was proceeding northwards along the river. As might be expected, Tits were most abundant in the woods. We saw vast numbers of *Acredula caudata*, and *Parus major*, *ater*, *palustris*, and *cæruleus*, but no Crested Tits, though they are said to be found. Nuthatches were not uncommon. I saw a few Wrens. Wherever there were streams there were White Wagtails (*Motacilla alba*). These are, of course, summer migrants, but had arrived in thousands, and were all, it seemed, paired. Whether they were still moving northwards I had unfortunately no means of discovering. I saw at some distance one pair of yellowish birds which appeared to be *M. melanope*, but I did not satisfactorily identify them. Greenfinches were tolerably abundant, and we saw a few flocks of Goldfinches. The House-Sparrow was strangely uncommon. We saw very few, and only, occasionally, actually in villages. On the other hand, there were numbers of the more delicately formed and attractive Tree-Sparrows in the old apple-trees by the roadsides. I noted a few Linnets at one spot; also a single female Bullfinch. Yellow Buntings were plentiful everywhere, and in the Main Valley, where there are some small reed-beds, a few pairs of Reed-Buntings were to be seen. Starlings were exceedingly abundant. In the forest there were large numbers of Jays, but Magpies, which are so conspicuous in most parts of North Germany, were absent. On the other hand, in four days I saw more Carrion-Crows than, I think, I had seen in all my previous life. There were thousands of them both in the forest and in the cultivated places. They were all *Corvus corone*, and we saw no Hooded Crows among them. Some were in pairs, but the majority in flocks of two hundred to three hundred. The only birds that were more plentiful than Crows were Chaffinches, of which we saw enormous flocks. Sky-Larks were much less numerous than in the flat plains of North Germany.

Before daylight one morning I recognized the unmistakable song of the Crested Lark, and saw several on the waste land outside the railway station at Hanau. This was the only place where I saw any. The song is sweetly modulated but short and is uttered on the wing, and also, as often as not, when the bird is perched on a roof. Buzzards (*Buteo vulgaris*) seem to be tolerably plentiful in the district. I am told that they are regarded as harmless, and are protected in Germany. We saw several each day and heard their familiar squeals. On the 27th we saw two Kites playing and swooping over the river just outside the small town of Wertheim. Whilst so engaged, one

was attacked and severely buffeted by a Carrion Crow for no apparent reason. It was strange that the huge bird of prey appeared quite incapable of resenting the impertinence of the Crow. On the 28th, about ten miles down the river, we saw three Kites together, and watched them for a long time in the air and perching most conspicuously on bare trees above the road. The Kites were all *Milvus ictinus*. It is possible that they may have been the same as those seen the day before who were migrating by easy stages northwards. These three Kites were in company of four Buzzards, and one had the rare pleasure of seeing these fine Accipitres together on the wing over one's head. The form and flight of the Buzzard and Kite on the wing are strikingly different, though both soar in easy curves with motionless wings. Seen from underneath, the tail of the Buzzard is short, square, and not forked. The wings are obtuse and carried horizontally. The tail of the Kite is long, narrow, and most distinctly forked. The wings are carried at an acuter angle over the back when soaring than those of the Buzzard. The only other bird of prey seen was a single Kestrel. We saw one Heron, and on March 28th a single Stork, apparently just arrived at his old nest and sitting as though feeling the cold. Green Woodpeckers abound, and the bird is an ancient symbol of the Spessart. The Great Black Woodpecker (*Dryocopus martius*) seemed to be fairly plentiful, but very shy. There can be few districts more accessible to the English ornithologist who wishes to study this noble Picarian bird. The flight is characterized by the dipping movement of the other Woodpeckers, and the loud ringing cry has a roll and a deeper note than the familiar "yaffler." I should write it down: "True-true-true," &c. We heard a number, but only succeeded in once getting a view of the bird. In the forest were small numbers of Wood-Pigeons but no large flocks; and I saw a party of half a dozen Stock-Doves drinking in the evening at a brook. An ornithologist who explored the Spessart in May and June when migration was complete and nesting going on would no doubt be well rewarded. The best starting-point is Aschaffenburg on a main line of railway. Excellent maps showing marked footpaths through the forest can be got there.—HAROLD RUSSELL (16, Beaufort Gardens, London).

INSECTA.

Notes on Culex vexans (Meigen) and Osmylus fulvicephalus.—On March 22nd last I found, in a pool formed by rain-water in a wood, a number of larvæ of a species of gnat. These larvæ in

no way appeared to me to differ from those of *Culex pipiens*, except that they were very large, about 10 mm. long. I took about two dozen or so of these larvæ home, which I confined in a vessel of water. I thought at the time the early date was very much against their being those of *C. pipiens*. All works on entomology I consulted were unanimous in deciding that the breeding of this insect was in early summer. The larvæ I had gradually diminished in numbers, one by one, and disappeared. Query: Were the rest guilty of cannibalism? The remaining larvæ turned into nymphs on May 18th, and the perfect insect appeared on May 20th. This unusually long period from larva to imago struck me as curious, so I sent to Mr. Austen of the British Museum a tube containing larva, nymph, and fly in spirit. He very kindly supplied me with the following information:—"I write to say that the Mosquito larvæ and pupæ are not those of *Culex pipiens*, but belong to the species known as *Culex vexans* (Meigen), about which our knowledge is as yet very scanty. Mr. C. O. Waterhouse found the larvæ of this species in a large pond at Brockenhurst, in the New Forest, at the end of March 22nd, 1905, so that March 22nd would not appear to be an unusually early date for the larvæ; but whether the species passes through the winter in the larval state I am unable to say. Curiously enough, all the perfect insects bred by Mr. Waterhouse are males [mine were also males], and apparently he failed to breed a single female. If you are ever able to obtain females of *C. vexans*, I should be glad of a few specimens for our Collection. They should either be pinned on fine pins, or, if dead, sent dry in a tube containing a few pieces of cigarette or tissue paper in order to prevent the specimens from being injured by shaking about. Your specimens certainly seem to have been an unusually long time in reaching the perfect state; this was perhaps due to the lack of some necessary food material in the water." (My specimens had pond water supplied to them.) It is perhaps worth while to mention that last year I took here numbers of another "New Forest insect," namely, *Osmylus fulvicephalus*, which I sent to Mr. Kirby for the National Collection. Mr. Waterhouse, in acknowledging these specimens, wrote to me that he had only met with it in the New Forest, "but it is not a common one, or at any rate it is very local." In 1908 I saw numbers of these insects at Watersmeet, in North Devon.—Gordon Dalgliesh (The Cottage, Brook, Godalming, Surrey).

NOTICES OF NEW BOOKS.

Concealing-Coloration in the Animal Kingdom, &c. Being a Summary of Abbott H. Thayer's *Discoveries.* By Gerald H. Thayer. New York: The Macmillan Co.

The "obliteration" theory of Mr. A. H. Thayer has been enunciated by its author in several scientific papers, and so is known to most students of philosophical zoology; the present beautifully illustrated volume condenses previous advocacy, and gives further evidence for the theory, thus presenting the whole argument in its favour. That concealment by "obliteration" cannot very well be accepted as supporting the usual theory of the purposes of animal disguises is clear from a paragraph in the "Introduction" by Mr. A. H. Thayer himself. He writes:—"This discovery that patterns and utmost contrasts of color (not to speak of *appendages*) on animals make *wholly* for their 'obliteration,' is a fatal blow to the various theories that these patterns exist *mainly* as nuptial dress, warning colors, mimicry devices (*i. e.* mimicry of one species by another), &c., since these are all attempts to explain an entirely false conception that such patterns make their wearer *conspicuous*." Even in birds, "changeable colors of all sorts strongly tend to conceal the birds that wear them, and *iridescence* is extraordinarily potent in this way. Its power is of two kinds, which are, however, practicably inseparable in their working. First, it goes far toward annulling the normal lights and shadows, with their color-effects, of the surface on which it is placed; and, second, its great and vivid versatility of color and shade almost insures the 'matching' of some part of that surface with whatever forms its background."

These two extracts will more or less focus the Thayerian argument, which must almost certainly greatly modify much theory as regards present advanced mimicry and phases in

animal coloration, for which a number of terms have now been invented as though they were theological definitions. The theory of Mr. Thayer describes a universal phenomenon which is more consonant with a progressive evolution than the partial and abrupt disguises predicated in the current teachings of mimicry. All animals in a state of nature seek concealment from their foes, in some form or another all have that protection, and the "obliterative" suggestion thus explains very much. In the evolutionary process all animals must have also slowly acquired a knowledge of the benefits arising from this obliterative protection, so that active concealment by animal volition should be considered as a factor in this phenomenon, a course which will strengthen rather than weaken its comprehension.

In Mr. Thayer's description of the obliterative markings of the Zebra we find no reference to Mr. Francis Galton, who, in the 'Narrative of an Explorer in Tropical South Africa,' published in 1853 (chap. x.), not only discussed the "bright colours of skulking animals," especially that of the Zebra, but may be said to have been the first, in other words, to propound the theory of "obliterative coloration."

The many and beautiful illustrations in this volume supplement and explain the text.

The Vertebrate Fauna of Cheshire and Liverpool Bay. Edited by T. A. Coward, F.Z.S. Witherby & Co.

The two beautiful volumes that comprise this last addition to our knowledge of the local or county zoology of the British Islands are edited and largely written by our old and well-known contributor, Mr. T. A. Coward, who, with another valued contributor, Mr. C. Oldham, are entirely answerable for the first volume relating to the mammals and birds.

Of the mammals, we are told, forty-six species occur or have occurred within recent years in Cheshire and its territorial waters. "Very little documentary evidence exists of the recently extinct mammalian fauna, and owing to the absence from Cheshire of limestone caverns, which have yielded a rich harvest of remains of the Pleistocene Age in the neigh-

bouring counties of York, Derby, Denbigh, and Flint, our knowledge of the more ancient fauna is slight." The marine mammalian fauna is not extensive owing to "the short mileage of the actual Cheshire coast, the shallowness of Liverpool Bay, and the distance of the estuaries from the main route of migratory cetaceans and seals." The Bats are fully treated, and much information derived from actual observation is given; this was to have been expected, for our authors, even in the pages of 'The Zoologist,' have given frequent proof of their local study of these animals. The account of the domesticated herd of polled white Park Cattle kept at Somerford Park, near Congleton, is fully illustrated, and contains many interesting facts and figures.

"There is satisfactory evidence of the occurrence in a wild state of two hundred and thirty-one species of birds in Cheshire during the present and last centuries," and since the publication of the same authors' 'Birds of Cheshire' in 1900 several species have been added to the county list. These comprise the Cirl Bunting, Mealy Redpoll, Woodchat, Shore Lark, Shag, American Blue-winged Teal, Kentish Plover, Schlegel's Petrel, and Baillon's Crake. One hundred and twelve species breed, or bred until recently, within the county boundaries. The Nightingale is included on the grounds of greater probability. At the end of April, 1896, we read that a Nightingale made its appearance in a hanging wood at Oakwood Hall, on the bank of the Mersey, the property then of a late resident, Ephraim Hallam. The presence of the bird or birds attracted "large crowds," and, apprehensive of damage to his property, Ephraim Hallam gave instructions that the Nightingale should be scared away. This was done by the firing of blank cartridges—one beneath the tree in which the bird was singing. "The male was neither seen nor heard again, but it is not certain that the firing was responsible for the silence, as two days later the gardener saw the hen with food in her beak, and it appears probable that the eggs were then hatched."

Vol. ii. opens with an account of "The Dee as a Wildfowl Resort," by Mr. John A. Dockray. It is the same old story of what is called industrial civilization destroying the beauties of nature; adding to the mercantile wealth of a county by the obliteration

of its natural charms. "What must this estuary have been like a hundred years ago? Can we picture it before railways existed on either side, before any serious reclamation had taken place, when there were no puffing, snorting tugs, with their shrill whistles, in the tideway, no clanging steam-hammers or shrieking 'devils' at the unbuilt works, &c.—nothing, in short, to disturb the solitude of those endless miles of flat, flat-marsh, and sand-bank." Perhaps in another two thousand years it may have reverted back to its old condition, and the birds come to their own again. Mr. Dockray's contribution will comfort the soul of the sportsman.

The "Reptiles and Amphibians" are from the pens of Messrs. Coward and Oldham, who have not a wide range in subject. "Although two out of the three British Snakes, the two Lizards, and the Blindworm occur or have occurred within recent years, Cheshire has a remarkably poor reptilian fauna; no single species can be called common."

Mr. James Johnstone has undertaken the enumeration of "The Fishes of Cheshire and Liverpool Bay," and he has done more by giving an introduction to the physical conditions of the Cheshire sea area, and of the systematic position of the species. However, space forbids further extracts from a more than usually important, interesting, and thorough piece of zoological work.

Experiments on the Generation of Insects. By Francesco Redi, of Arezzo. Translated by Mab Bigelow. Chicago: The Open Court Publishing Co.

The 'Esperienze Intorno alla Generazione degl' Insetti' is now seldom read, and, like its author, almost forgotten. The book was published in 1668, and reached its fifth edition in 1688, from which this translation has been made. A Latin version appeared at Amsterdam in 1671, while Pouchet (1859) makes mention of a French translation. We must put on the scientific equipment of 1668 to understand what this publication really meant at that time, and what the author dared to say at that epoch, though he fought with the foils of Erasmus and escaped persecution.

Francesco Redi was born in Arezzo, Tuscany, in 1626, sixteen years after the publication of Galileo's 'Sydereus Nuncius,' and six years before his 'Dialogues on the Ptolemaic and Copernican Systems,' at a time "when the twenty-century old authority of Aristotle was still undiminished," while Bruno, Campanella, Varini, and Kepler—all critics of Aristotle—had made straighter the way for Redi.

Redi was mentally brought up under the care of the Jesuit Fathers, his parents were of the provincial nobility, and his father was a well-known physician. Francesco became a power at the Court of Ferdinand II., and of his son and successor, the bigoted Cosimo III. Although Redi never lost the friendship of the Jesuit Fathers, he effectually disposed of another Aristotelian theory or acceptance—that of spontaneous generation in animal life. This is his fame and the reputation of his work. He commenced by simple experimental methods, first, with three dead Snakes, which were placed in an open box to decay; and we need not recapitulate the discovery of "worms," their subsequent pupal condition, and the ultimate emergence of flies. Even then he began to believe that the worms were derived directly from the droppings of flies, and was still more confirmed in this belief by having observed that before the meat grew wormy flies had hovered over it, of the same kind as those that later bred in it; whilst he further stated: "Nor am I in the least degree convinced by the authoritative statement of Father Honoré Fabri, of the venerable Company of Jesus, who asserts, in his book on the 'Generation of Animals,' that flies always drop eggs and never worms." It is clear that at this time Redi was behind the outlook of Fabri, and had yet much to learn.

The argument used by Redi against the spontaneous generation of bees is, of course, more or less vitiated by his confusion of the drone-fly (*Eristalis*) with the bee (*Apis*), and he affirmed against the opinion that bees originated in the flesh of bulls, even though "the learned Father Honoré Fabri, whose famous works will never be buried in the gloom of oblivion," reiterates this belief. But here our experimental observer was "sharply reminded" of the fourteenth chapter of the Book of Judges, containing the observations of Samson on this matter. Of the

opinions of other contemporary philosophers which must have vexed the spirit of Redi, we read of Servius, the Grammarian, who "turned everything topsy-turvy by asserting that drones come from horses, hornets from mules, and wasps from asses." We have also a delightful account of one experiment made by our reformer. "Having had frequent proof that animals killed by a snake's bite, or by tobacco, which is a terrible poison, can be eaten with impunity," he gave some Pigeons killed by "the sting of the angry Scorpion" to a poor man, "who was overjoyed, and ate them with great gusto, and they agreed with him very well."

Here we must leave Francesco Redi, and with no better remembrance than his modest termination to his book, which was addressed to Carlo Dati:—"In the meanwhile, be assured that this letter or book, as you please to call it, has come to you not for praise but for correction, which I heartily beg you to give; being well aware that—

'My name unto the world is little known.'"

The translation appears to be well done and expressed in simple language, while the book may well be read as a description of the biological outlook of two hundred and fifty years ago. Let us also modestly consider what may be the biological verdict of our present-day conceptions two hundred and fifty years hence.

The British Freshwater Rhizopoda and Heliozoa. By James Cash. Assisted by John Hopkinson, F.L.S., &c. Ray Society.

In our volume for 1906 we drew the reader's attention to the first volume of this monograph; the second is now published, and contains the second part of the Rhizopoda.

It is one of the merits of most monographs that they soon become behind the time; they focus the knowledge to date, arouse enthusiasm in new workers, and thus cause the publication of other work which should represent new material and method, but which would never have appeared but for the earlier volume. The very first paragraph in the present volume is

illustrative: "Owing to the discovery in Britain, since the first volume of this monograph was published, of Arcellida belonging to genera not then known to be represented in this country, the list of British genera of the Arcellida on page 37 of vol i. requires revision."

James Cash, the author of these volumes, appears to have been one of those naturalists whose work is of the patient character, and whose personality is unobtrusive. Mr. Hopkinson, in his history of the work, writes:—"In November, 1902, amongst the letters written to our late Secretary, the Rev. Dr. Wiltshire, I found one dated 8th July, 1902, commencing thus: 'A life-long friend, Mr. James Cash of Manchester, has devoted thirty years' time, special knowledge, and enthusiasm to the writing of a monograph on the Rhizopoda. He has also done with his own hands an excellent and adequate equipment of plates to illustrate the text, and, I speak as an old Quekett man, these drawings are distinguished by an ideal measure of faithfulness to nature, loving care, and artistic beauty.'" The work had been offered to two of our chief publishers of natural history books, who, while expressing approval, would not undertake the publication without the author would bear the whole financial risk. Here, again, the Ray Society, by its publication of Mr. Cash's monograph, has proved itself a real patron in natural history. The author, however, died somewhat suddenly in 1909, and to Mr. Hopkinson belongs the credit of not only editing this work, but also compiling its extensive synonymy.

This second volume contains plates xvii. to xxxii., many of which are coloured, besides numerous figures in the text.

Bulletin of Entomological Research. Issued by the Entomological Research Committee (Tropical Africa), appointed by the Colonial Office. Vol. i. part 1. Longmans, Green & Co.

There can be no doubt that this newly appointed Research Committee should effect quite a revolution in our knowledge of the economic entomology of Tropical Africa. Under the presidency of the Earl of Cromer an influential Committee has been formed, some members of which are well-known economic

entomologists. The Scientific Secretary is Mr. Guy Marshall, from whose knowledge and energy much may be expected, and he has edited the first number of the 'Bulletin,' which contains several papers of no inconsiderable importance.

When we consider the large amount of work that has been done in this field by many workers at their own loss in time and money, it is indeed cheering to find our Government at last taking the matter in hand, and by State aid giving an impetus to a study that is important to every civilized community, and which has been raised to the highest consideration in the United States of North America. In South Africa there are already several State entomologists, distributed in the Cape Colony and in the Transvaal, and the outlook is very different to what it was in quite recent times, when President Kruger refused to aid in the destruction of predatory locusts on the ground that those insects had been sent by the Deity as a punishment for the sins of the land.